

air respirators. Skin protection is not generally necessary, but where there is a history of zircon granuloma from deodorants, it is probably advisable.

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MISCELLANEOUS INORGANIC COMPOUNDS

AMMONIA

DESCRIPTION

NH_3 , ammonia, is a colorless, strongly alkaline, and extremely soluble gas with a characteristic pungent odor.

SYNONYMS

None.

POTENTIAL OCCUPATIONAL EXPOSURES

Ammonia is used as a nitrogen source for many nitrogen-containing compounds. It is used in the production of ammonium sulfate and ammonium nitrate for fertilizers and in the manufacture of nitric acid, soda, synthetic urea, synthetic fibers, dyes, and plastics. It is also utilized as a refrigerant and in the petroleum refining, chemical, and pharmaceutical industries.

Other sources of occupational exposure include the silvering of mirrors, gluemaking, tanning of leather, and around nitriding furnaces. Ammonia is produced as a by-product in coal distillation and by the action of steam on calcium cyanamide, and from the decomposition of nitrogenous materials.

A partial list of occupations in which exposure may occur includes:

Aluminum workers	Metal powder processors
Annealers	Mirror silverers
Chemical laboratory workers	Paper makers
Chemical workers	Paper pulp makers
Dye makers	Pesticide makers
Electroplate workers	Rayon makers
Fertilizer workers	Refrigeration workers
Galvanizers	Sulfuric acid workers
Glue makers	Tannery workers
Metal extractors	Water treaters

PERMISSIBLE EXPOSURE LIMITS

The Federal standard for ammonia is an 8-hour time weighted average of 50 ppm (35 mg/m³). NIOSH has recommended 50 ppm expressed as a ceiling and determined by a 5-minute sampling period.

ROUTE OF ENTRY

Inhalation of gas.

HARMFUL EFFECTS*Local—*

Contact with anhydrous liquid ammonia or with aqueous solutions is intensely irritating to the mucous membranes, eyes, and skin. Eye symptoms range from lacrimation, blepharospasm, and palpebral edema to a rise of intraocular pressure, and other signs resembling acute-angle closure glaucoma, corneal ulceration, and blindness. There may be corrosive burns of skin or blister formation. Ammonia gas is also irritating to the eyes and to moist skin.

Systemic—

Mild to moderate exposure to the gas can produce headache, salivation, burning of throat, anosmia, perspiration, nausea, vomiting, and substernal pain. Irritation of ammonia gas in eyes and nose may be sufficiently intense to compel workers to leave the area. If escape is not possible, there may be severe irritation of the respiratory tract with the production of cough, glottal edema, bronchospasm, pulmonary edema, or respiratory arrest. Bronchitis or pneumonia may follow a severe exposure if patient survives. Urticaria is a rare allergic manifestation from inhalation of the gas.

MEDICAL SURVEILLANCE

Preemployment physical examinations for workers in ammonia exposure areas should be directed toward significant changes in the skin, eyes, and respiratory system. Persons with corneal disease, and glaucoma, or chronic respiratory diseases may suffer increased risk. Periodic examinations should include evaluation of skin, eyes, and respiratory system, and pulmonary function tests to compare with baselines established at preemployment examination.

SPECIAL TESTS

None.

PERSONAL PROTECTIVE METHODS

Where ammonia hazards exist in concentrations above the standard, respiratory, eye, and skin protection should be provided. Fullface gas masks with ammonia canister or supplied air respirators, both with full facepieces, afford good protection. In areas where exposure to liquid ammonia occurs, goggles or face shields, as well as protective clothing impervious to ammonia and including gloves, aprons, and boots should be required. Where ammonia gas or concentrated ammonia solution is

splashed in eyes, immediate flooding of the eyes with large quantities of water for 15 minutes or longer is advised, followed at once by medical examination. In heavy concentrations of ammonia gas, workers should be outfitted with complete self-contained protective suits impervious to ammonia, with supplied air source, and full headpiece and facepiece. Work clothes wetted with concentrated ammonia solutions should be changed immediately, and the exposed area of the body washed thoroughly with water.

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CALCIUM OXIDE

DESCRIPTION

CaO, calcium oxide, occurs as white or grayish-white lumps or granular powder. The presence of iron gives it a yellowish or brownish tint. It is soluble in water and acids.

SYNONYMS

Lime, burnt lime, quicklime, calx, fluxing lime.

POTENTIAL OCCUPATIONAL EXPOSURES

Calcium oxide is used as a refractory material, a binding agent in bricks, plaster, mortar, stucco and other building materials, a dehydrating agent, a flux in steel manufacturing, and a laboratory agent to absorb CO₂; in the manufacture of aluminum, magnesium, glass, pulp and paper, sodium carbonate, calcium hydroxide, chlorinated lime, calcium salts, and other chemicals; in the flotation of nonferrous ores, water and sewage treatment, soil treatment in agriculture, dehairing hides, the clarification of cane and beet sugar juice, and in fungicides, insecticides, drilling fluids, and lubricants.

A partial list of occupations in which exposure may occur includes:

Brick masons	Paper makers
Fertilizer makers	Plaster makers
Fungicide workers	Steel workers
Glass makers	Sugar refiners
Insecticide makers	Tannery workers
Metal smelters	Water treaters
Mortar workers	

PERMISSIBLE EXPOSURE LIMITS

The Federal standard for calcium oxide is 5 mg/m³.

ROUTE OF ENTRY

Inhalation of dust.

HARMFUL EFFECTS

Local—

The irritant action of calcium oxide is due primarily to its alkalinity and exothermic reaction with water. It is irritating and may be caustic to the skin, conjunctiva, cornea, and mucous membranes of upper respiratory tract, may produce burns or dermatitis with desquamation and vesicular rash, lacrimation, spasmodic blinking, ulceration, and ocular perforation, ulceration and inflammation of the respiratory passages, ulceration of nasal and buccal mucosa, and perforation of nasal septum.

Systemic—

Bronchitis and pneumonia have been reported from inhalation of dust. The lower respiratory tract is generally not affected because irritation of upper respiratory passages is so severe that workers are forced to leave the area.

MEDICAL SURVEILLANCE

Preemployment physical examinations should be directed to significant problems of the eyes, skin, and the upper respiratory tract. Periodic examinations should evaluate the skin, changes in the eyes, especially the cornea and conjunctiva, mucosal ulcerations of the nose, mouth, and nasal septum, and any pulmonary symptoms. Smoking history should be known.

SPECIAL TESTS

None in common use.

PERSONAL PROTECTIVE METHODS

In areas where workers are exposed to calcium oxide levels above the standard, protection to the skin, eyes, and respiratory tract should be provided. Skin protection can be provided by protective clothing and gloves. All dusty area workers should be provided with goggles and dust masks with proper cartridges. Personal hygiene is to be encouraged, with frequent change of work clothes and showering after each shift before change to street clothes.

CARBON DIOXIDE

DESCRIPTION

CO₂, carbon dioxide, is a colorless, odorless, non-combustible gas, soluble in water. It is commonly sold in the compressed liquid form, and the solid form (dry ice).

SYNONYMS

Carbonic acid gas, carbonic anhydride.

POTENTIAL OCCUPATIONAL EXPOSURES

Gaseous carbon dioxide is used to carbonate beverages, as a weak acid in the textile, leather, and chemical industries, in water treatment,

and in the manufacture of aspirin and white lead, for hardening molds in foundries, in food preservation, in purging tanks and pipelines, as a fire extinguisher, in foams, and in welding. Because it is relatively inert, it is utilized as a pressure medium. It is also used as a propellant in aerosols, to promote plant growth in green houses; it is used medically as a respiratory stimulant, in the manufacture of carbonates, and to produce an inert atmosphere when an explosive or flammable hazard exists. The liquid is used in fire extinguishing equipment, in cylinders for inflating life rafts, in the manufacturing of dry ice, and as a refrigerant. Dry ice is used primarily as a refrigerant.

Occupational exposure to carbon dioxide may also occur in any place where fermentation processes may deplete oxygen with the formation of carbon dioxide, e.g., in mines, silos, wells, vats, ships' holds, etc.

A partial list of occupations in which exposure may occur includes:

Aerosol packagers	Grain elevator workers
Beverage carbonators	Inert atmosphere welders
Blast furnace workers	Insecticide makers
Brewery workers	Miners
Carbonic acid makers	Refrigerating car workers
Charcoal burners	Refrigerating plant workers
Chemical synthesizers	Soda makers
Explosive makers	Tannery workers
Fire extinguisher makers	Textile workers
Firemen	Vatmen
Foundry workers	Well cleaners

PERMISSIBLE EXPOSURE LIMITS

The Federal standard is 5,000 ppm (9,000 mg/m³).

ROUTE OF ENTRY

Inhalation of gas.

HARMFUL EFFECTS

Local—

Frostbite may result from contact with dry ice or gas at low temperature.

Systemic—

Carbon dioxide is a simple asphyxiant. Concentrations of 10% (100,000 ppm) can produce unconsciousness and death from oxygen deficiency. A concentration of 5% may produce shortness of breath and headache. Continuous exposure to 1.5% CO₂ may cause changes in some physiological processes. The concentration of carbon dioxide in the blood affects the rate of breathing.

MEDICAL SURVEILLANCE

No special considerations are necessary although persons with cardiovascular or pulmonary disease may be at increased risk.

SPECIAL TESTS

None in common use.

PERSONAL PROTECTIVE METHODS

Carbon dioxide is a heavy gas and accumulates at low levels in depressions and along the floor. Generally, adequate ventilation will provide sufficient protection for the worker. Where concentrations are of a high order, supplied air respirators are recommended.

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CARBON MONOXIDE

DESCRIPTION

CO, carbon monoxide, is a colorless, odorless, tasteless gas, partially soluble in water, but one which decomposes.

SYNONYMS

None.

POTENTIAL OCCUPATIONAL EXPOSURES

Carbon monoxide is used in metallurgy as a reducing agent, particularly in the Mond process for nickel; in organic synthesis, especially in the Fischer-Tropsch process for petroleum products and in the oxo reaction; and in the manufacture of metal carbonyls.

It is usually encountered in industry as a waste product of incomplete combustion of carbonaceous material (complete combustion produces CO₂). The major source of CO emission in the atmosphere is the gasoline-powered internal combustion engine. Specific industrial processes which contribute significantly to CO emission are iron foundries particularly the cupola; fluid catalytic crackers, fluid coking, and moving-bed catalytic crackers in petroleum refining; lime kilns and Kraft recovery furnaces in Kraft paper mills; furnace, channel, and thermal operations in carbon black plants; beehive coke ovens, basic oxygen furnaces, sintering of blast furnace feed in steel mills; and formaldehyde manufacture. There are numerous other operations in which a flame touches a surface that is cooler than the ignition temperature of the gaseous part of the flame where exposure to CO may occur, e.g., arc welding, automobile repair, traffic control, tunnel construction, fire fighting, mines, use of explosives, etc.

A partial list of occupations in which exposure may occur includes:

Acetylene workers	Metal oxide reducers
Blast furnace workers	Miners
Boiler room workers	Mond process workers
Brewery workers	Organic chemical synthesizers
Carbon black makers	Petroleum refinery workers
Coke oven workers	Pulp and paper workers
Diesel engine operators	Steel workers
Garage mechanics	Water gas workers

PERMISSIBLE EXPOSURE LIMITS

The present Federal standard is 50 ppm (55 mg/m³). The standard recommended by NIOSH is 35 ppm with a ceiling value of 200 ppm. This latter value is to limit carboxyhemoglobin formation to 5% in a nonsmoker engaged in sedentary activity at normal altitude.

ROUTE OF ENTRY

Inhalation of gas.

HARMFUL EFFECTS

Local—

None.

Systemic—

Carbon monoxide combines with hemoglobin to form carboxyhemoglobin which interferes with the oxygen carrying capacity of blood, resulting in a state of tissue hypoxia. The typical signs and symptoms of acute CO poisoning are headache, dizziness, drowsiness, nausea, vomiting, collapse, coma, and death. Initially the victim is pale; later the skin and mucous membranes may be cherry-red in color. Loss of consciousness occurs at about the 50% carboxyhemoglobin level. The amount of carboxyhemoglobin formed is dependent on concentration and duration of CO exposure, ambient temperature, health, and metabolism of the individual. The formation of carboxyhemoglobin is a reversible process. Recovery from acute poisoning usually occurs without sequelae unless tissue hypoxia was severe enough to result in brain cell degeneration.

Carbon monoxide at low levels may initiate or enhance deleterious myocardial alterations in individuals with restricted coronary artery blood flow and decreased myocardial lactate production.

Severe carbon monoxide poisoning has been reported to permanently damage the extrapyramidal system, including the basal ganglia.

MEDICAL SURVEILLANCE

Preplacement and periodic medical examinations should give special attention to significant cardiovascular disease and any medical conditions which could be exacerbated by exposure to CO. Heavy smokers may be at greater risk. Methylene chloride exposure may also cause an

increase of carboxyhemoglobin. Smokers usually have higher levels of carboxyhemoglobin than nonsmokers (often 5 - 10% or more).

SPECIAL TESTS

Carboxyhemoglobin levels are reliable indicators of exposure and hazard.

PERSONAL PROTECTIVE METHODS

Under certain circumstances where carbon monoxide levels are not exceedingly high, gas masks with proper canisters can be used for short periods but are not recommended. In areas with high concentrations, self-contained air apparatus is recommended.

GRAPHITE

DESCRIPTION

Graphite is crystallized carbon and usually appears as soft, black scales. There are two types of graphite, natural and artificial.

SYNONYMS

Plumbago, black lead, mineral carbon.

POTENTIAL OCCUPATIONAL EXPOSURES

Natural graphite is used in foundry facings, steelmaking, lubricants, refractories, crucibles, pencil "lead," paints, pigments, and stove polish. Artificial graphite may be substituted for these uses with the exception of clay crucibles; other types of crucibles may be produced from artificial graphite. Additionally, it may be used as a high temperature lubricant or for electrodes. It is utilized in the electrical industry in electrodes, brushes, contacts, and electronic tube rectifier elements; as a constituent in lubricating oils and greases; to treat friction elements, such as brake linings; to prevent molds from sticking together; and in moderators in nuclear reactors.

A partial list of occupations in which exposure may occur includes:

Brake lining makers	Match makers
Cathode ray tube makers	Nuclear reactor workers
Commutator brush makers	Paint makers
Crucible makers	Pencil lead makers
Electrode makers	Pigment makers
Explosive makers	Refractory material makers
Foundry workers	Steel makers
Lubricant makers	Stove polish makers

PERMISSIBLE EXPOSURE LIMITS

The Federal standard for natural graphite is 15 mppcf.

ROUTE OF ENTRY

Inhalation of dust.

HARMFUL EFFECTS

Local—

None.

Systemic—

Exposure to natural graphite may produce a progressive and disabling pneumoconiosis similar to anthracosilicosis. Symptoms include headache, coughing, depression, decreased appetite, dyspnea, and the production of black sputum. Some individuals may be asymptomatic for many years then suddenly become disabled. It has not yet been determined whether the free crystalline silica in graphite is solely responsible for development of the disease. There is evidence that artificial graphite may be capable of producing a pneumoconiosis.

MEDICAL SURVEILLANCE

Preemployment and periodic examinations should be directed toward detecting significant respiratory disease, through chest X-rays and pulmonary function tests.

SPECIAL TESTS

None.

PERSONAL PROTECTIVE METHODS

Workers in exposed areas should be provided with dust masks with proper cartridges and should be instructed in their maintenance.

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HYDROGEN PEROXIDE

DESCRIPTION

H₂O₂, anhydrous hydrogen peroxide, is a colorless rather unstable liquid with a bitter taste. Hydrogen peroxide is completely miscible with water and is commercially sold in concentrations of 3, 35, 50, 70, and 90 percent solutions.

SYNONYMS

Peroxide, hydrogen dioxide, hydroperoxide.

POTENTIAL OCCUPATIONAL EXPOSURES

Hydrogen peroxide is used in the manufacture of acetone, antichlor, antiseptics, benzol peroxide, buttons, disinfectants, pharmaceuticals, felt hats, plastic foam, rocket fuel, and sponge rubber. It is also used in

bleaching bone, feathers, flour, fruit, fur, gelatin, glue, hair, ivory, silk, soap, straw, textiles, wax, and wood pulp, and as an oxygen source in respiratory protective equipment. Other specific occupations with potential exposure include liquor and wine agers, dyers, electroplaters, fat refiners, photographic film developers, wool printers, veterinarians, and water treaters.

A partial list of occupations in which exposure may occur includes:

Acetone makers	Fat refiners
Alcoholic beverage agers	Hide disinfectors
Antichlor makers	Metal cleaners
Antiseptic makers	Photographic film developers
Benzol peroxide makers	Plastic foam makers
Button makers	Rocket fuel workers
Disinfectant makers	Sponge rubber makers
Drug makers	Veterinarians
Dyers	Water treaters
Electroplaters	Wool printers

PERMISSIBLE EXPOSURE LIMITS

The Federal standard for hydrogen peroxide (90 percent) is 1 ppm (1.4 mg/m³).

ROUTE OF ENTRY

Inhalation of vapor or mist.

HARMFUL EFFECTS

Local—

The skin, eyes, and mucous membranes may be irritated by concentrated vapor or mist. Bleaching and a burning sensation may occur at lower levels, while high concentrations may result in blistering and severe eye injury, which may be delayed in appearance.

Systemic—

Inhalation of vapor or mist may produce pulmonary irritation ranging from mild bronchitis to pulmonary edema. No chronic systemic effects have been observed.

MEDICAL SURVEILLANCE

Preplacement and periodic examinations should be directed to evaluation of the general health with particular reference to the skin, eyes, mucous membranes, and respiratory tract.

SPECIAL TESTS

None.

PERSONAL PROTECTIVE METHODS

In areas where concentrated hydrogen peroxide is being used, if there is danger of spill or splash, skin protection should be provided by protective clothing, gloves, goggles, and boots. Where fumes or vapor are excessive, workers should be provided with gas masks with full face pieces and proper canisters or supplied air respirators. Additional health hazards may occur from the decomposition of hydrogen peroxide. Oxygen, possibly at high pressure, may form, which may create an explosion hazard. Hydrogen peroxide is generally handled in a closed system to prevent contamination.

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HYDROGEN SULFIDE

DESCRIPTION

H₂S, hydrogen sulfide, is a flammable, colorless gas with a characteristic rotten-egg odor and is soluble in water.

SYNONYMS

Sulfuretted hydrogen, hydrosulfuric acid, stink damp.

POTENTIAL OCCUPATIONAL EXPOSURES

Hydrogen sulfide is used in the synthesis of inorganic sulfides, sulfuric acid, and organic sulfur compounds, as an analytical reagent, as a disinfectant in agriculture, and in metallurgy. It is generated in many industrial processes as a by-product and also during the decomposition of sulfur-containing organic matter, so potential for exposure exists in a variety of situations. Hydrogen sulfide is found in natural gas, volcanic gas, and in certain natural spring waters. It may also be encountered in the manufacture of barium carbonate, barium salt, cellophane, depilatories, dyes and pigments, felt, fertilizer, adhesives, viscose rayon, lithopone, synthetic petroleum products; in the processing of sugar beets; in mining, particularly where sulfide ores are present; in sewers and sewage treatment plants; during excavation of swampy or filled ground for tunnels, wells, and caissons; during drilling of oil and gas wells; in purification of hydrochloric acid and phosphates; during the low temperature carbonization of coal; in tanneries, breweries, slaughterhouses; in fat rendering; and in lithography and photoengraving.

A partial list of occupations in which exposure may occur includes:

Barium carbonate makers	Rayon makers
Brewery workers	Sewage treatment plant workers
Caisson workers	Sewer workers
Cellophane makers	Silk makers
Coke oven workers	Slaughterhouse workers
Depilatory makers	Soap makers
Dye makers	Sugar beet processors
Fat renderers	Sulfuric acid purifiers
Felt makers	Sulfur makers
Lithographers	Synthetic fiber makers
Miners	Tannery workers
Natural gas makers	Tunnel workers
Paper pulp makers	Well diggers
Photoengravers	

PERMISSIBLE EXPOSURE LIMITS

The Federal standard is a ceiling value of 20 ppm (30 mg/m³) with a maximum peak above this value for an 8-hour shift of 50 ppm (75 mg/m³) for a maximum duration of 10 minutes once only if no other measurable exposure occurs.

ROUTE OF ENTRY

Inhalation of gas.

HARMFUL EFFECTS

Local—

Palpebral edema, bulbar conjunctivitis, keratoconjunctivitis, and ocular lesions may occur when hydrogen sulfide comes in contact with the eyes. Photophobia and lacrimation may also develop. Direct irritation of the respiratory tract may cause rhinitis, pharyngitis, bronchitis, and pneumonia. Hydrogen sulfide may penetrate deep into the lungs and cause hemorrhagic pulmonary edema. Hydrogen sulfide's irritative effects are due to the formation of alkali sulfide when the gas comes in contact with moist tissues.

Systemic—

Acute exposure may cause immediate coma which may occur with or without convulsions. Death may result with extreme rapidity from respiratory failure. Post-mortem signs include a typical greenish cyanosis of the chest and face with green casts found in viscera and blood. The toxic action of hydrogen sulfide is thought to be due to inhibition of cytochrome oxidase by binding iron which is essential for cellular respiration. Subacute exposure results in headache, dizziness, staggering gait, and excitement suggestive of neurological damage, and nausea and diarrhea suggestive of gastritis. Recovery is usually complete although rarely polyneuritis may develop as a result of vestibular and extrapyra-

midal tract damage. Tremors, weakness, and numbness of extremities may also occur. Physicians may observe a "rotten-egg" breath and abnormal electrocardiograms in victims. Systemic effects from chronic exposure to hydrogen sulfide have not been established.

MEDICAL SURVEILLANCE

Preplacement medical examinations should evaluate any preexisting neurological, eye, and respiratory conditions and any history of fainting seizures.

SPECIAL TESTS

None in common use for surveillance purposes.

PERSONAL PROTECTIVE METHODS

Hydrogen sulfide's strong odor, noticeable at low concentrations, is a poor warning sign as it may cause olfactory paralysis, and some persons are congenitally unable to smell H₂S.

Accidental exposure may occur when workers enter sewage tanks and other confined areas in which hydrogen sulfide is formed by decomposition. In a number of cases workers enter unsuspectingly and collapse almost immediately. Workers, therefore, should not enter enclosed spaces without proper precautions.

All Federal standard and other safety precautions must be observed when tanks or other confined spaces are to be entered. In areas where the exposure to hydrogen sulfide exceeds the standards, workers should be provided with fullface canister gas masks or preferably supplied air respirators.

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NITROGEN OXIDES

DESCRIPTION

Nitrogen oxides include:
 Nitrous oxide: N₂O
 Nitric oxide: NO
 Nitrogen dioxide: NO₂

Nitrogen trioxide: N_2O_3
 Nitrogen tetroxide: N_2O_4
 Nitrogen pentoxide: N_2O_5
 Nitric acid: HNO_3
 Nitrous acid: HNO_2

Nitrous oxide, N_2O , is a colorless, noncombustible gas, sweet-tasting, and slightly soluble in water. Nitric oxide is a colorless gas slightly soluble in water. Nitric oxide combines with oxygen to form nitrogen dioxide which is a reddish-brown gas with a characteristic odor. Nitrogen dioxide exists in equilibrium with nitrogen tetroxide, and these two compounds and oxygen are in equilibrium with the crystalline nitrogen pentoxide. However, nitrogen dioxide and nitric oxide are the dissociation products of nitrogen trioxide. When nitrogen dioxide comes in contact with water, nitrous acid and nitric acid are formed. Nitric acid is a colorless liquid when pure, but on exposure to light, the liquid may turn yellowish-brown as a result of nitrogen dioxide formation. Nitric acid mist almost always contains nitrogen oxide gases and is, therefore, included in this group. Nitrogen dioxide decomposes in water, Nitrogen pentoxide is slightly soluble in water and nitric acid (70% aqueous solution) is soluble in water.

SYNONYMS

Nitrous oxide: Nitrogen monoxide
 Nitric oxide: Mononitrogen monoxide
 Nitrogen dioxide: None
 Nitrogen trioxide: Dinitrogen trioxide, nitrous anhydride
 Nitrogen tetroxide: Dinitrogen tetroxide
 Nitrogen pentoxide: Nitric anhydride
 Nitrous acid: None
 Nitric acid: Aqua fortis, azotic acid, hydrogen nitrate

POTENTIAL OCCUPATIONAL EXPOSURES

Exposure to nitrogen oxides is typically a mixed exposure to "nitrous fumes" which may evolve from various manufacturing processes and in many other industrial situations. Exposure to nitrogen oxides may occur during the manufacture of nitric and sulfuric acid, oxidized cellulose compounds, explosives, rocket propellants, fertilizers, dyes and dyestuffs, pharmaceuticals, and various other organic and inorganic chemicals such as nitrites, nitrates, and other nitro compounds, aqua regia, arsenic acid, oxalic acid, nitrous acid, phthalic acid, and phosphoric acid. Exposure may also occur during jewelry manufacturing, etching, brazing, lithographing, metal cleaning, textile (rayon) and food bleaching, glass blowing, electroplating, gas and electric arc welding, and during the nitration of chloroform. Nitrogen oxides also occur in garages from automobile exhaust, in silos from organic material decomposition, in tunnels following blasting, and when nitric acid comes in contact with organic materials.

A partial list of occupations in which exposure may occur includes:

Braziers	Medical technicians
Dentists	Metal cleaners
Dye makers	Nurses
Fertilizer makers	Organic chemical synthesizers
Food and textile bleachers	Photoengravers
Garage workers	Physicians
Gas and electric arc welders	Silo fillers
Jewelry makers	Sulfuric acid makers

PERMISSIBLE EXPOSURE LIMITS

The Federal standards are: nitric oxide — 25 ppm (30 mg/m³), nitrogen dioxide — 5 ppm (9 mg/m³), and nitric acid — 2 ppm (5 mg/m³); determined as a TWA. Currently there are no standards for the other listed compounds. NIOSH has recommended a ceiling level of 1 ppm for nitrogen dioxide.

ROUTES OF ENTRY

Inhalation of gas in the case of nitrogen oxide gases; inhalation of the mist or vapor, in the case of nitric and nitrous acids.

HARMFUL EFFECTS

Local—

Nitrogen oxide gases may produce irritation of the eyes and mucous membranes. Prolonged low level exposure may produce yellowish or brownish staining of the skin and teeth; however, this sign usually indicates nitric acid exposure. Nitric acid and nitrogen tetroxide are extremely corrosive liquids and may cause severe burns, ulcers, and necrosis of the skin, mucous membranes, and eye tissues.

Systemic—

Exposure to high concentrations of nitrogen oxides may result in severe pulmonary irritation and methemoglobinemia. The former is believed to be caused by the nitrogen dioxide portion, while the latter is mainly caused by nitric oxide. It is postulated that nitric oxide is non-irritating but the distinction is of questionable importance since nitric oxide exposure generally includes other nitrogen oxides; moreover, nitric oxide at even moderate concentrations oxidizes rapidly and spontaneously in the presence of atmospheric oxygen.

Nitrogen dioxide at high concentrations has also been shown to cause methemoglobinemia in the dog. Typically, acute exposure may produce immediate malaise, cyanosis, cough, dyspnea, chills, fever, headache, nausea, and vomiting. Collapse and death may occur if exposure is sufficiently high. When lower concentrations are encountered, there may be only mild signs of bronchial irritation followed by a five- to twelve-hour symptom-free period. Subsequently, the onset of signs and symptoms of acute pulmonary edema occur suddenly, which unfortunately may take place away from prompt medical aid.

Nitrogen oxides may be formed from green silage in amounts which,

when restrained to the confines of a silo, may constitute a serious health hazard. "Silo-filler's disease" is the name used to designate the syndrome culminating in bronchiolitis fibrosa obliterans, caused by exposure to nitrogen oxides evolved in this way.

If the acute episode is survived, bronchiolitis fibrosa obliterans may develop usually within a few days but may be latent for as long as six weeks. Victims may develop severe and increasing dyspnea which is often accompanied by fever and cyanosis. Chest roentgenogram may reveal a diffuse, reticular, and fine nodular infiltration or numerous, uniform, scattered nodular densities ranging in size from 1 to 5 mm in diameter.

Chronic exposure may result in pulmonary dysfunction with decreased vital capacity, maximum breathing capacity and lung compliance, and increased residual volume. The most common complaint is of dyspnea upon exertion. Signs include moist rales and wheezes, sporadic cough with mucopurulent expectoration, a decrease in blood pH and serum proteins, and an increase in urinary hydroxyproline and acid mucopolysaccharides. These findings are suggestive of emphysema, although they are as yet inconclusive.

The development of methemoglobinemia is typically mild and transient. In rare cases individuals may have a preexisting constantly high methemoglobin level due to a genetic defect. Such individuals are more susceptible to toxic methemoglobinemia.

MEDICAL SURVEILLANCE

Preplacement and periodic examinations should be concerned particularly with the skin, eyes, and with significant pulmonary and heart diseases. Periodic chest X-rays and pulmonary function tests may be useful. Smoking history should be known. Methemoglobin studies may be of interest if exposure to nitric oxide is present. In the case of nitric acid vapor mist exposure, dental effects may be present.

SPECIAL TESTS

None.

PERSONAL PROTECTIVE METHODS

Workers should not enter confined areas where nitrogen oxides may accumulate (for example, silos) without appropriate eye and respiratory protection.

Individuals should be equipped with supplied air respirators with full face piece or chemical goggles, and enclosed areas should be properly ventilated before entering. An observer equipped with appropriate respiratory protection should be outside the area and standing by to supply any aid needed.

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OZONE

DESCRIPTION

O₃, ozone, is a bluish gas with a characteristic pungent odor, slightly soluble in water. Ozone is found naturally in the atmosphere as a result of the action of solar radiation and electrical storms. It is also formed around electrical sources such as X-ray or ultraviolet generators, electric arcs, mercury vapor lamps, linear accelerators, and electrical discharges.

SYNONYMS

None.

POTENTIAL OCCUPATIONAL EXPOSURES

Ozone is used as an oxidizing agent in the organic chemical industry (e.g., production of azelaic acid); as a disinfectant for food in cold storage rooms and for water (e.g., public water supplies, swimming pools, sewage treatment); for bleaching textiles, waxes, flour, mineral oils and their derivatives, paper pulp, starch, and sugar; for aging liquor and wood; for processing certain perfumes, vanillin, and camphor; in treating industrial wastes; in the rapid drying of varnishes and printing inks; and in the deodorizing of feathers.

Industrial exposure often occurs around ozone generating sources, particularly during inert-gas shielded arc welding.

A partial list of occupations in which exposure may occur includes:

Air treaters	Organic chemical synthesizers
Arc welders	Sewage treaters
Cold storage food preservers	Textile bleachers
Industrial waste treaters	Water treaters
Liquor agers	Wax bleachers
Odor controllers	Wood agers
Oil bleachers	

PERMISSIBLE EXPOSURE LIMITS

The Federal standard is 0.1 ppm (0.2 mg/m³).

ROUTES OF ENTRY

Inhalation of the gas.

HARMFUL EFFECTS*Local—*

Ozone is irritating to the eyes and all mucous membranes. In human exposures, the respiratory signs and symptoms in order of increasing ozone concentrations are: dryness of upper respiratory passages; irritation of mucous membranes of nose and throat; choking, coughing, and severe fatigue; bronchial irritation, substernal soreness, and cough. Pulmonary edema may occur, sometimes several hours after exposure has ceased. In severe cases, the pulmonary edema may be fatal.

Animal experiments demonstrate that ozone causes inflammation and congestion of respiratory tract and, in acute exposure, pulmonary edema, hemorrhage, and death.

Chronic exposure of laboratory animals resulted in chronic bronchitis, bronchiolitis, emphysematous and fibrotic changes in pulmonary parenchyma.

Systemic—

Symptoms and signs of subacute exposure include headache, malaise, shortness of breath, drowsiness, reduced ability to concentrate, slowing of heart and respiration rate, visual changes, and decreased desaturation of oxyhemoglobin in capillaries. Animal experiments with chronic exposure showed aging effects and acceleration of lung tumorigenesis in lung-tumor susceptible mice.

Animal experiments further demonstrated that tolerance to acute pulmonary effects of ozone is developed and that this provided cross tolerance to other edemagenic agents. Antagonism and synergism with other chemicals also occur.

Ozone also has radiomimetic characteristics, probably related to its free-radical structure. Experimentally produced chromosomal aberrations have been observed.

MEDICAL SURVEILLANCE

Preemployment and periodic physical examinations should be concerned especially with significant respiratory diseases. Eye irritation may also be important. Chest X-rays and periodic pulmonary function tests are advisable.

SPECIAL TESTS

None.

PERSONAL PROTECTIVE METHODS

In areas of excessive concentration, gas masks with proper canister and fullface piece or goggles or the use of supplied air respirators is recommended.

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PHOSGENE

DESCRIPTION

COCl_2 , phosgene, is a colorless, noncombustible gas with a sweet, not pleasant odor in low concentrations. In higher concentrations, it is irritating and pungent. It decomposes in water but is soluble in organic solvents.

SYNONYMS

Carbonyl chloride, carbon oxychloride, carbonic acid dichloride, chloroformyl chloride, combat gas.

POTENTIAL OCCUPATIONAL EXPOSURES

Phosgene is used in the manufacture of dyestuffs based on triphenylmethane, coal tar, and urea. It is also used in the organic synthesis of isocyanates and their derivatives, carbonic acid esters (polycarbonates), and acid chlorides. Occasional applications include its utilization in metallurgy, and in the manufacture of some insecticides and pharmaceuticals.

A partial list of occupations in which exposure may occur includes:

Chlorinated compound makers	Insecticide makers
Drug makers	Metallurgists
Dye makers	Organic chemical synthesizers
Firemen	

PERMISSIBLE EXPOSURE LIMITS

The Federal standard for concentrations of phosgene in air is 0.1 ppm (0.4 mg/m^3).

ROUTE OF ENTRY

Inhalation of gas.

HARMFUL EFFECTS

Local—

Conjunctivitis, lacrimation, and upper respiratory tract irritation may develop from gas. Liquid may cause severe burns.

Systemic—

Acute exposure to phosgene may produce pulmonary edema frequently preceded by a latent period of 5-6 hours but seldom longer than 12 hours. The symptoms are dizziness, chills, discomfort, thirst, increasingly tormenting cough, and viscous sputum. Sputum may then be

come thin and foamy, and dyspnea, a feeling of suffocation, tracheal rhonci, and grey-blue cyanosis may follow. Death may result from respiratory or cardiac failure. The hazard of phosgene is increased because at low levels (205 mg/m³) it is lacking in warning symptoms.

Chronic exposure to phosgene may result in some tolerance to acute edemagenic doses, but may cause irreversible pulmonary changes of emphysema and fibrosis. Animal experimentation has shown an increased incidence of chronic pneumonitis and acute and fibrinous pneumonia from exposure to this agent.

MEDICAL SURVEILLANCE

Preemployment medical examinations should include chest X-rays and baseline pulmonary function tests. The eyes and skin should be examined. Smoking history should be known. Periodic pulmonary function studies should be done. Workers who are known to have inhaled phosgene should remain under medical observation for at least 24 hours to insure that delayed symptoms do not occur.

SPECIAL TESTS

None.

PERSONAL PROTECTIVE METHODS

Where liquid phosgene is encountered, protective clothing should be supplied which is impervious to phosgene. Where gas is encountered above safe limits, fullface gas masks with phosgene canister or supplied air respirators should be used.

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PORTLAND CEMENT

DESCRIPTION

Portland cement is a class of hydraulic cements whose two essential constituents are tricalcium silicate and dicalcium silicate with varying amounts of alumina, tricalcium aluminate, and iron oxide. The quartz content of most is below one percent. The average composition of regular Portland cement is as follows:

CaO: 64 %
 SiO₂: 21 %
 Al₂O₃: 5.8 %
 FeO₃: 2.9 %
 MgO: 2.5 %
 Alkali Oxides: 1.4 %
 SO₃: 1.7 %

SYNONYMS

None.

POTENTIAL OCCUPATIONAL EXPOSURES

Cement is used as a binding agent in mortar and concrete (a mixture of cement, gravel, and sand). Potentially hazardous exposure may occur during both the manufacture and use of cement.

A partial list of occupations in which exposure may occur includes:

Asbestos cement workers	Drain tile makers
Brick masons	Heat insulation makers
Bridge builders	Oil well builders
Building construction workers	Silo builders
Burial vault builders	Storage tank builders
Cement workers	Tunnel builders
Concrete workers	Water pipe makers

PERMISSIBLE EXPOSURE LIMITS

The Federal standard for Portland cement is 50 mppcf.

ROUTE OF ENTRY

Inhalation of dust.

HARMFUL EFFECTS

Local—

Exposure may produce cement dermatitis which is usually due to primary irritation from the alkaline, hygroscopic, and abrasive properties of cement. Chronic irritation of the eyes and nose may occur. In some cases, cement workers have developed an allergic sensitivity to constituents of cement such as hexavalent chromate. It is not unusual for cement dermatitis to be prolonged and to involve covered areas of the body.

Systemic—

No documented cases of pneumoconiosis or other systemic manifestations attributed to finished Portland cement exposure have been reported. Conflicting reports of pneumoconiosis from cement dust appear related to exposures that occurred in mining, quarrying, or crushing silica-containing raw materials.

MEDICAL SURVEILLANCE

Preemployment and periodic medical examinations should stress significant respiratory problems, chest X-ray, pulmonary function tests, smoking history, and allergic skin sensitivities, especially to chromates. The eyes should be examined.

SPECIAL TESTS

Patch test studies may be useful in dermatitis cases.

PERSONAL PROTECTIVE METHODS

In areas exceeding safe dust levels, masks with proper cartridges

should be provided. Gloves, barrier creams, and protective clothing (long sleeved shirts, etc.) will help protect workers subject to dermatitis. Personal hygiene is very important, and all cement workers should be encouraged to shower following each shift before changing to street clothes. Freshly laundered work clothing should be supplied on a daily basis.

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SODIUM HYDROXIDE/POTASSIUM HYDROXIDE

DESCRIPTION

NaOH, sodium hydroxide, is a white, deliquescent material sold as pellets, flakes, lumps, or sticks. It is soluble in water, alcohol, and glycérine. Aqueous solutions are known as soda lye.

KOH, potassium hydroxide, exists as white or slightly yellow deliquescent lumps, rods, or pellets. It is soluble in water. Aqueous solutions are known as lye.

SYNONYMS

Sodium hydroxide: caustic soda, caustic alkali, caustic flake, sodium hydrate.

Potassium hydroxide: potassium hydrate, caustic potash, potassa, caustic alkali.

POTENTIAL OCCUPATIONAL EXPOSURES

Sodium hydroxide is utilized to neutralize acids and make sodium salts in petroleum refining, viscose rayon, cellophane, and plastic production, and in the reclamation of rubber. It hydrolyzes fats to form soaps, and it precipitates alkaloids and most metals from aqueous solutions of their salts. It is used in the manufacture of mercerized cotton, paper, explosives, and dyestuffs, in metal cleaning, electrolytic extraction of zinc, tin plating, oxide coating, laundering, bleaching, and dish-washing, and it is used in the chemical industries.

Potassium hydroxide is used in the manufacture of liquid soap, as a mordant for wood, as a carbon dioxide absorber, in mercerizing cotton, in electroplating, photoengraving, and lithography, in printing inks, in paint and varnish removers, and in analytical chemistry, organic synthesis, and the production of other potassium compounds.

A partial list of occupations in which exposure may occur includes:

Bleachers	Paint removers
Bleach makers	Paper makers
Cellophane makers	Photoengravers
Chemical laboratory workers	Printers
Dye makers	Printing ink makers
Electroplaters	Rayon makers
Etchers	Rubber reclaimers
Explosive makers	Soap makers
Laundry workers	Textile bleachers
Lithographers	Tin platers
Mercerizers	Varnish removers
Organic chemical synthesizers	Zinc extractors

PERMISSIBLE EXPOSURE LIMITS

The Federal standard for sodium hydroxide is 2 mg/m³. There is no standard for potassium hydroxide.

ROUTE OF ENTRY

Inhalation of dust or mist.

HARMFUL EFFECTS

Local—

Both compounds are extremely alkaline in nature and are very corrosive to body tissues. Dermatitis may result from repeated exposure to dilute solutions in the form of liquids, dusts, or mists.

Systemic—

Systemic effects are due entirely to local tissue injury. Extreme pulmonary irritation may result from inhalation of dust or mist.

MEDICAL SURVEILLANCE

The skin, eyes, and respiratory tract should receive special attention in any placement or periodic examination.

SPECIAL TESTS

None.

PERSONAL PROTECTIVE METHODS

Protection should be provided by impervious protective clothing, rubber boots, face and eye shields, and dust respirators. All skin area burns, especially of the eyes, demand immediate care by flooding with large quantities of water for 15 minutes or longer and specialized medical care.

SULFUR CHLORIDE

DESCRIPTION

S₂Cl₂, sulfur chloride, is a fuming, oily liquid with a yellowish-red

to amber color and a suffocating odor. It has an added hazard since it oxidizes and hydrolyzes to sulfur dioxide and hydrogen chloride.

SYNONYMS

Sulfur monochloride, sulfur subchloride, disulfur dichloride.

POTENTIAL OCCUPATIONAL EXPOSURES

Sulfur chloride finds use as a chlorinating agent and an intermediate in the manufacture of organic chemicals, e.g., carbon tetrachloride, and sulfur dyes, insecticides, synthetic rubber, and pharmaceuticals. Exposure may also occur during the extraction of gold, purification of sugar juice, finishing and dyeing textiles, processing vegetable oils, hardening wood, and vulcanization of rubber.

A partial list of occupations in which exposure may occur includes:

Carbon tetrachloride makers	Sulfur dye makers
Drug makers	Synthetic rubber makers
Gold extractors	Textile dye makers and finishers
Insecticide makers	Vegetable oil processors
Rubber workers	Wood hardeners
Sugar juice purifiers	

PERMISSIBLE EXPOSURE LIMITS

The Federal standard for sulfur chloride (sulfur monochloride) is 1 ppm (6 mg/m³).

ROUTE OF ENTRY

Inhalation of vapor.

HARMFUL EFFECTS

Local—

Fumes, in sufficient quantity, may cause severe irritation to eyes, skin, and mucous membranes of the upper respiratory tract.

Systemic—

Although this compound is capable of producing severe pulmonary irritation, very few serious cases of industrial exposure have been reported. This is probably because the pronounced irritant effects of sulfur chloride serve as an immediate warning signal when concentration of the gas approaches a hazardous level.

MEDICAL SURVEILLANCE

Preemployment and periodic examinations should give special emphasis to the skin, eyes, and respiratory system. Pulmonary function tests may be useful. Exposures may also include sulfur dioxide and hydrochloric acid. (See these compounds).

SPECIAL TESTS

None are known to be useful.

PERSONAL PROTECTIVE METHODS

In areas where vapor levels are excessive, workers should be supplied with fullface gas masks with proper canister or supplied air respirators with full face piece. Skin protection can usually be afforded by work clothes and barrier creams, but under certain instances (spills, etc.), full impervious protective suits may be necessary.

SULFUR DIOXIDE

DESCRIPTION

SO₂, sulfur dioxide, is a colorless gas at ambient temperatures with a characteristic strong suffocating odor. It is soluble in water and organic solvents.

SYNONYMS

Sulfurous anhydride, sulfurous oxide.

POTENTIAL OCCUPATIONAL EXPOSURES

Sulfur dioxide is used in the manufacture of sodium sulfite, sulfuric acid, sulfuryl chloride, thionyl chloride, organic sulfonate, disinfectants, fumigants, glass, wine, ice, industrial and edible protein, and vapor pressure thermometers. It is also used in the bleaching of beet sugar, flour, fruit, gelatin, glue, grain, oil, straw, textiles, wicker ware, wood pulp, and wool; in the tanning of leather; in brewing and preserving; and in the refrigeration industry. Exposure may also occur in various other industrial processes as it is a by-product of ore smelting, coal and fuel oil combustion, paper manufacturing, and petroleum refining.

A partial list of occupations in which exposure may occur includes:

Beet sugar bleachers	Ore smelter workers
Boiler water treaters	Paper makers
Brewery workers	Petroleum refinery workers
Disinfectant makers	Protein makers
Diesel engine operators and repairmen	Refrigeration workers
Firemen	Sodium sulfite makers
Fumigant makers	Sulfuric acid makers
Furnace operators	Tannery workers
Gelatin bleachers	Thermometer makers (vapor)
Glass makers	Wine makers
Ice makers	Wood bleachers

PERMISSIBLE EXPOSURE LIMITS

The Federal standard is 5 ppm (13 mg/m³). NIOSH has recommended lowering this standard to 2 ppm as a TWA.

ROUTE OF ENTRY

Inhalation of gas. Direct contact of gas or liquid phase on skin and mucous membranes.

HARMFUL EFFECTS

Local—

Gaseous sulfur dioxide is particularly irritating to mucous membranes of the upper respiratory tract. Chronic effects include rhinitis, dryness of the throat, and cough. Conjunctivitis, corneal burns, and corneal opacity may occur following direct contact with liquid.

Systemic—

Acute over-exposure may result in death from asphyxia. Survivors may later develop chemical bronchopneumonia with bronchiolitis obliterans. Bronchoconstriction with increased pulmonary resistance, high-pitched rales, and a tendency to prolongation of the expiratory phase may result from moderate exposure, though bronchoconstriction may be asymptomatic. The effects on pulmonary function are increased in the presence of respirable particles.

Chronic exposure may result in nasopharyngitis, fatigue, altered sense of smell, and chronic bronchitis symptoms such as dyspnea on exertion, cough, and increased mucous excretion. Transient stimulation of erythropoietic activity of the bone marrow has been reported. Slight tolerance, at least to the odor threshold, and general acclimatization are common. Sensitization in a few individuals, particularly young adults, may also develop following repeated exposures. There is some evidence that some individuals may be innately hypersusceptible to SO_2 . Animal experimentation has also indicated that sulfur dioxide may be a possible co-carcinogenic agent.

MEDICAL SURVEILLANCE

Replacement and periodic medical examinations should be concerned especially with the skin, eye, and respiratory tract. Pulmonary function should be evaluated, as well as smoking habits, and exposure to other pulmonary irritants.

SPECIAL TESTS

None commonly used.

PERSONAL PROTECTIVE METHODS

In areas where levels of sulfur dioxide gas are excessive, the worker should be supplied with fullface piece cartridge or canister respirator or with supplied air respirators. Goggles, protective clothing, and gloves should be worn if splashes with liquid are likely. Work clothing should be changed at least twice a week to freshly laundered work clothes. Showering following each work shift should be encouraged. In areas of splash or spill, impervious clothing should be supplied, but if work clothes are wetted by sulfur dioxide, they should be promptly removed and the skin area thoroughly washed.

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SULFURIC ACID

DESCRIPTION

H_2SO_4 , concentrated sulfuric acid, is a colorless, odorless, oily liquid which is commercially sold at 93 to 98% H_2SO_4 , the remainder being water. Fuming sulfuric acid (oleum) gives off free sulfur trioxide and is a colorless or slightly colored, viscous liquid. Sulfuric acid is soluble in water and alcohol.

SYNONYMS

Oil of vitriol, spirit of vitriol, spirit of sulfur, hydrogen sulfate.

POTENTIAL OCCUPATIONAL EXPOSURES

Sulfuric acid is used as a chemical feedstock in the manufacture of acetic acid, hydrochloric acid, citric acid, phosphoric acid, aluminum sulfate, ammonium sulfate, barium sulfate, copper sulfate, phenol, superphosphates, titanium dioxide, as well as synthetic fertilizers, nitrate explosives, artificial fibers, dyes, pharmaceuticals, detergents, glue, paint, and paper. It finds use as a dehydrating agent for esters and ethers due to its high affinity for water, as an electrolyte in storage batteries, for the hydrolysis of cellulose to obtain glucose, in the refining of mineral and vegetable oil, and in the leather industry. Other uses include fur and food processing, carbonization of wool fabrics, gas drying, uranium extraction from pitchblende, and laboratory analysis.

A partial list of occupations in which exposure may occur includes:

Aluminum sulfate makers	Food processors
Battery makers	Glue makers
Cellulose workers	Jewelers
Chemical synthesizers	Leather workers
Copper sulfate makers	Metal cleaners
Detergent makers	Paint makers
Dye makers	Paper makers
Explosive makers	Phenol makers

PERMISSIBLE EXPOSURE LIMITS

The Federal standard for sulfuric acid is 1 mg/m³.

ROUTE OF ENTRY

Inhalation of mist.

HARMFUL EFFECTS

Local—

Burning and charring of the skin are a result of the great affinity for, and strong exothermic reaction with, water. Concentrated sulfuric acid

will effectively remove the elements of water from many organic materials with which it comes in contact. It is even more rapidly injurious to mucous membranes and exceedingly dangerous to the eyes. Ingestion causes serious burns of the mouth or perforation of the esophagus or stomach. Dilute sulfuric acid does not possess this property, but is an irritant to skin and mucous membranes due to its acidity and may cause irreparable corneal damage and blindness as well as scarring of the eyelids and face.

Systemic—

Sulfuric acid mist exposure causes irritation of the mucous membranes, including the eye, but principally the respiratory tract epithelium. The mist also causes etching of the dental enamel followed by erosion of the enamel and dentine with loss of tooth substance. Central and lateral incisors are mainly affected. Breathing high concentrations of sulfuric acid causes tickling in the nose and throat, sneezing, and coughing. At lower levels sulfuric acid causes a reflex increase in respiratory rate and diminution of depth, with reflex bronchoconstriction resulting in increased pulmonary air flow resistance. A single overexposure may lead to laryngeal, tracheobronchial, and pulmonary edema. Repeated excessive exposures over long periods have resulted in bronchitic symptoms, and rhinorrhea, lacrimation, and epistaxis. Long exposures are claimed to result in conjunctivitis, frequent respiratory infections, emphysema, and digestive disturbances.

MEDICAL SURVEILLANCE

Preplacement and periodic medical examinations should give special consideration to possible effects on the skin, eyes, teeth, and respiratory tract. Pulmonary function tests should be performed.

SPECIAL TESTS

None commonly used.

PERSONAL PROTECTIVE METHODS

In all areas where liquid sulfuric acid is handled, impervious clothing should be provided, including gloves, goggles or face mask, rubber suits, and rubber shoes. Any work clothing wetted by sulfuric acid should be immediately changed and the skin area thoroughly washed and flooded with water. In areas where mist or gas is excessive, gas masks with appropriate canister or supplied air respirators should be provided. In either instance the worker should be supplied with full face protection.

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